DOCUMENT RESUME

ED 429 829 SE 062 392

AUTHOR Wang, Sea-Yu Patrick; Guo, Chorng-Jee; Chiang, Wu-Hsiung; Cheng, Shiu-Shan

TITLE Teaching for Meaningful Understanding: A School-Based Science and Mathematics Teacher Development Project.

PUB DATE 1999-03-29
NOTE 17p.; Paper presented at the Annual Meeting of the National Association of Research in Science Teaching (Boston, MA, March 28-31, 1999).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Action Research; *Faculty Development; Foreign Countries; *Mathematics Education; *Reflective Teaching; *Science Education; *Secondary Education; Teacher Attitudes; Teacher Improvement
IDENTIFIERS Taiwan

ABSTRACT

The purpose of this ongoing project is to establish a model for school-based teacher development for secondary science and mathematics teachers in Taiwan. The model uses an action research approach with emphasis on constructivist perspectives of teaching and learning and the idea that teachers are to be taken as researchers and reflective practitioners. Implementation strategies for initiating such a collaborative teacher development project that were tested in one of the participating secondary schools are reported. The professional development of the participating teachers was studied by collecting data from sources such as surveys, questionnaires, and interviews. Results from preliminary analysis of the data collected indicate that while some teachers seemed to benefit greatly from this collaborative research, there were a few who were opposed to the project. Influencing factors for the practicability and effectiveness of the school-based professional development project are discussed. (WRM)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 429 829

Teaching for meaningful understanding: A school-based science and mathematics teacher development project

Paper presented at
1999 National Association for Research in Science Teaching
Boston, U.S.A., March 28-31, 1999

Sea-Yu Patrick Wang, Chorng-Jee Guo, Wu-Hsiung Chiang
and Shiu-Shan Cheng
Graduate Institute of Science Education, National Changhua
University of Education, Taiwan

BEST COPY AVAILABLE

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Teaching for meaningful understanding:

A school-based science and mathematics teacher development project.

Sea-Yu Patrick Wang, Chorng-Jee Guo, Wu-Hsiung Chiang

and Shiu-Shan Cheng

Graduate Institute of Science Education, National Changhua

University of Education, Taiwan

Abstract This is an ongoing research. The purpose of this study is to establish a model for school-based teacher development for the secondary science and mathematics teachers in Taiwan, using an action research approach with emphases on constructivist perspectives of teaching and learning, and ideas that teachers are to be taken as researchers and reflective practitioners. Implementation strategies which were tried out in one of the participating secondary schools for initiating such a collaborative teacher development project will be reported. The professional development of the participating teachers were studied by collecting data from sources such as survey, questionnaire and interview. Results from preliminary analysis of the data collected indicated that while some teachers seemed to benefit a lot as a result of this collaborative research, there were a few others who still opposed themselves to the project. Influencing factors for the practicability and effectiveness of the school-based professional development project will be discussed.

Key Words: School-based teacher development, Taiwan, Action Research, Constructivist, Collaborative Teacher Development project, Professional Development of Teachers

Teaching for meaningful understanding:
A school-based science and mathematics teacher development project

Sea-Yu Patrick Wang, Chorng-Jee Guo, Wu-Hsiung Chiang and Shiu-Shan Cheng
Graduate Institute of Science Education,
National Changhua University of Education, Taiwan

Background

For decades in Taiwan, the aim to equip students with the necessary knowledge and skills to achieve better scores in the high school entrance exams has dominated science and mathematics instructions at the secondary school level to the extent that most students tend to equate the study of these subjects with rote memory of facts and formulae. Consequently most secondary science and mathematics teachers tend to believe that providing well-organized teacher-directed instructions and extensive practices on contrived pencil-and-paper problems seem to be the most appropriate and effective teaching approaches (Wang, 1998). As a result of such instructions which are based on objectivist views of teaching and learning, many students have little experiences participating in hands-on/minds-on learning activities or doing lab experiments, and often fail to grasp a basic and meaningful understanding of science and mathematics.

Facing the challenge of a science/technology/information oriented society of the upcoming century and the national calls for educational reform, means to initiate systemic change as to how science and mathematics should be taught in schools have been carried out at all levels from the Ministry of Education down to local schools. In the past few years, we have conducted a three-year action research project aiming to re-design an on-campus summer professional development program for the in-service secondary sciences and mathematics teachers (Cheng, et al., 1998). The goals of this

project were to provide participating teachers with a better theoretical understanding and practical experience of teaching and learning based on constructivist perspectives (Tobin, 1993), to encourage them to be critical and reflective about their teaching practices (Schon, 1987), and to support them to carry out classroom action research to improve their teaching (Elliott, 1991). Results of the previous studies showed that only a small number of teachers, who had kept close contact with our research team during a three-year period, were able to not only change their beliefs of teaching and learning but also put their beliefs into practice successfully. We also found that constant and long-term supports from the research team, peer teachers and school administrators were key elements which contributed to the teachers' commitment to change. These findings seemed to recommend it may be the case as Bridges (1993) argued that a school-based teacher development program running in partnership with higher education could provide a more effective solution to developing teachers professionally and producing a more wide-spread changes in the schools.

Purposes of the Study

From our previous studies, the success of those teachers who have improved their teaching based on a more constructivist viewpoint has drawn a lot of attention of their principals (Guo, Chiang & Chang, 1997). Through our survey we found that a number of those principals showed strong interest in having other science and mathematics teachers in their schools to be able to work with us towards the same direction. With funds sponsored by the National Science Council, we then decided to work with two local secondary schools to initiate a school-based professional development project for science and mathematics teachers. An action research approach was also integrated into this project so that we could keep track of the progress of this project, analyze what strategies appear to work for or against our goals, and thereby, to continuously

identify problems we are facing and to come up with new solutions. The overall purpose of this study is to build up a school-based professional development model in reference to Taiwan's context within which the in-service science and mathematics teachers would be able to develop professionally. In other words, we need to clearly address the interactive relationships between the research team and the participating teachers, the school administrators and the participating teachers, as well as the research team and the school administrators in order to achieve this goal. In this respect, the progress and impact of this school-based science and mathematics teacher enhancement project on one of the two participating secondary schools will be reported in this article.

Methods

An ideal teaching environment for school teachers is one in which their ideas for education can be practically applied in classrooms. Yet the real world situation in Taiwan's schools often presents teachers with a different picture. The teachers are frequently, if not always, challenged by the contradiction of the real life situation with the textbook case. Many teachers may opt to compromise with the real world situation no matter how contradictory it might be (Wang, 1998). It is a considerable yet important task for the action research to investigate the factors that lead teachers to make decisions under such pressure and to assist teachers find a negotiable ground to cope with the pressure and apply their newly learned constructivist teaching approaches.

As stated, the interactive relationships between the research team, the participating school authority and the participating teachers need to be addressed clearly before we can make any reasonable suggestions on the real problems about school-based professional development. We shall describe it as a trilogy of building

up a Taiwanese style school-based professional development model. It is constructed by the interaction of the research team, the administrative authority of participating school and the participating teachers following three explorative steps. In particular, two main aspects of methodology which would be directly related to the achieving of the aims have been taken into consideration. They are the drawing up of the intervention strategies and the developing of data collecting procedures. The formation of intervention strategies was aiming at constructing a path for the participating teachers to appreciate the benefits brought about by applying alternative constructivist approaches in their teaching. As for the data collection our main concern was, on the nature of action research, how can we collect data in the ways that provide us information with urgent needs while not to hamper the willingness of those participating teachers in continuing to take part in the program.

In this regard, initially a questionnaire survey was conducted in four nearby junior high schools to evaluate their willingness of taking part in the project. Two schools showed their intention of joining in. Afterwards a three-day workshop to introduce the pedagogic ideas with special reference to constructivism to the participating teachers was held. In the schools all the participating teachers were suggested to form three sub-groups according to their specific subjects. Every week the representative teachers from each sub-group were suggested to apply the ideas which they learned from the workshop to conduct a demonstrative teaching. Inculding our research team, the teachers other than the demonstrating one, the principal and director of the participating school all were invited to attend the demontrations and the debrief sessions. The overall procedures were recorded by video cameras. Also a group of participating teachers were selected to interview during which the study was undergoing in order to let the research team clarify some points they have made at the demontrations and/or at the discussions or do the follow-up investigations.

The Proceeding of Trilogy and the Findings

Preliminary Stage

There are around 30 classes at each grade level and a student population of 4,000 or so in this participating school. This school has the same curriculum with any other junior high schools in Taiwan, i.e. mathematics is taught from 7th to 9th grades, biology taught only in the seventh grade, physics and chemistry, while being integrated into one subject, is taught in 8th and 9th grades. Being an experienced and well determined administrator, the principal strongly suggested that in order to implement reforms of science and mathematics instruction in the school, it's better sooner than later, all the science and mathematics teachers of his school should get involved in the collaborated school-based professional development project. The following excerpt of the speech made by this principal to his teachers illustrates how the organizational culture might be shaped by a determined leader.

> "We will put the teaching approaches in accordance with constructivism into practice in our school this year. It's an irresistible trend…As far as I am concerned some of you have learned the concepts of constructivism while others haven't. Don't worry about that never have you heard about constructivism. We have got a few pieces of reading material about constructivism from the NCUE. You may find they are really helpful. You should know I also learned basic ideas about constructivism from reading them…In the future, we will strengthen our cooperative relationship with the NCUE…"

And this might in turn reflect the necessity of the sophisticate step a leader need to take in order to shake the conventional ideas imbedding in his/her organization.

Since constructivist teaching approaches are strongly emphasized in the newly released textbooks for the 7th-grade biology and mathematics courses, the principal

decided that those teachers who were then teaching these courses should firstly participate in this teacher development project. Although the physics/chemistry teachers would not be using the new textbook until next year, the principal also announced that the 8th-grade physics/chemistry teachers should also get prepared and start changing the way they were teaching. It was under these circumstances that there were 18 seventh-grade mathematics teachers, 7 seventh-grade biology teachers and 18 eighth-grade physics/chemistry teachers who took part in this school-based science and mathematics teacher development project during the 1997 school year. The approaches with which the project was carried out went through the following steps.

Step 1: Inspiring the Confidence for a Fresh Start

The project began with a half-day workshop in the summer of 1997 for each of the three groups of teachers, respectively. Each of the workshop was led by science and mathematics educators who are specializing in the subject matters from our research team. Basically, these workshops covered topics on current problems of secondary science and mathematics education, contemporary trends and goals of science and mathematics education, theory and practice of constructivist teaching approaches, classroom action researches. It was found that only about one-third of the number of teachers were able to participate. This might attribute to the reasons that these workshops were attended on a voluntary basis and were held at the university campus rather than at the teachers' own school. The teachers' less enthusiastic attitude might be illustrated by the excerpt of statements from a senior mathematics teacher.

> "Where I live is far away from here [i.e. the National Changhua University of Education]. Besides I don't think this sort of courses would help me much in my teaching. They are too theoretical. What I need is a set of rules that I can immediately apply in my classrooms..."

This sort of teachers' reluctant attitude might reflect a long-term existing problem in Taiwan's school education. For the past four decades an educational system with centralised control and standardised curriculum has helped to foster the majority of teachers a tendency of relying heavily upon prescribed textbooks and teaching submissively (Wang, 1998). It is a crucial issue for the research team to be able to help the participating teachers overcome the restriction of conventional bonds.

After these workshops, therefore, we discussed with the school principal on the follow-up action that we could carry out in the fall semester of 1997 to help the teachers try out the new teaching approaches they learned from the workshops. Accordingly we decided that the participating teachers should firstly form collaborative teams to figure out how to teach in accordance with the constructivist viewpoints. Then during the first semester, each team should designate one of the teachers in their team to use the strategies in the demonstrative teaching in front of an audience consisted of other teachers in the school and collaborating university researchers. There were three main purposes for such an arrangement. Firstly, it was expected to provide an opportunity for the teachers to think seriously about their teaching and what constructivism can contribute. Secondly, it provided examples for other teachers who would like to try out the new teaching approaches. Finally, the research team could provide immediate suggestions and feedback in the debrief sessions right after their demonstrative teachings.

However, after one semester of the implementation of this approach, the results did not turn out as what had been expected. For example, teachers complained that they did not know why they had to change the ways they used to teach. Neither did they display to have acquired the sufficient knowledge and skills about how to teach in accordance with the constructivist viewpoints. The following excerpts from the

statements of a representative math teacher may illustrate this sort of concerns.

> "To compare with the teaching in accordance with constructivist approaches the conventional teaching methods [i.e. using blackboard and chalk in whole class dictation] would be more acceptable [for us] because we are not familiar with the constructivist approaches. We are worrying our students may eventually "construct" [emphasised] something wrong if we adopt those constructivist approaches."

As a matter of fact, some teachers even claimed that they and their students were so frightened before and during the demonstrative teaching as not being able to completely realize what is this "new teaching method" all about. Moreover, a few other teachers expressed that attending the demonstrative teaching simply wasted their time because there was nothing in the demonstration worth of learning. Because of these pitfalls, our research team then decided to make some changes to this approach in the following semester.

Step 2: Establishing a Mechanism of Effective Communication

After discussing with the principal and the representatives of teachers about the problems we have encountered during the first semester, we believed that we needed to spend more time to communicate with the participating teachers about the purpose of this study. Most importantly, we recognized that these teachers were also learners. Teachers learn, think, and teach, as Shymansky indicated, by using their existing conceptions of the nature of teaching and learning (Shymansky, 1992). Their conceptions of what counts as good teaching of science and mathematics were very difficult to change. In view of the existing literature on students' conceptual change (Posner *et.al.*, 1982), we realized that it would take more steps than just point out to them about the problems and limitations of their current teaching practices and

recommend sound alternatives based on the constructivist points of view. As a result, in the spring semester of 1998, the approach for teacher development was significantly changed. In addition to the arrangement made last semester, the teachers were asked to attend meetings led by the research team at least a week ahead before they made the demonstrative teaching. These meetings not only provided an opportunity for teachers to exchange their concerns with our research team, but also evoked discussions among the teachers with regards to their teaching practices and issues related to the planning of their instruction. We also invited the teachers who had been working with us practicing the constructivist teaching approaches for many years to join these meetings as well as the follow-up demonstrative teaching. Not only did they provide suggestions for preparing the demonstrative teaching and feedback in the debrief sessions, but also they shared their reflections and experiences of how they went through the change process and why they were doing it. For example, one physics/chemistry teachers concluded the impact of his participating this research on the changing of his ideas about teaching as:

> "Before studying the ideas of constructivism I originally thought that the status of a teacher, in terms of teaching, should be sacred and authoritative. After one year's experience in learning and teaching in accordance with constructivist concepts, I would like to modify my teaching styles. Now I realized that there probably be nothing absolutely authoritative. Not even the established scientific theories. So I am more tolerable than I have ever been to my students' alternative ideas. I then used their alternative ideas, through discussions, as a channel to enhance our interaction in my classrooms."

Their presence seemed to attract more attention from the participating teachers and stimulate more in-depth discussions.

Step 3: Improving Teachers' Skills through On-site Clinical Diagnosis

Following the previous steps we found that we must profoundly explore the factors behind resisting attitude of some of the participating teachers. It has been found that some structural and functional factors in Taiwan's secondary education might have contributed to the formation of school ecology which mediated the teaching culture of teachers (Wang, 1998). Our preliminary analysis indicates that this might be the case the resisting attitude shown by some of the participating teachers also attributed to these two factors. The structural factor mainly has to do with the school administrative system and the levels beyond that. There is no doubt that the administrative authority of the participating school has strong will to push the alternative constructivist teaching approaches forward. Besides, we can see in recent years, the outside expectation on the nation's educational system is moving to a more liberal direction. In this regard, how will these tendencies have positive impact on the participating teachers is worth closely examining. We also found, at this stage, that the functional factor has more to do with teachers' subjective concepts on education and their value system than other elements. Therefore we discerned it might be worth trying to change teachers' mind by adopting piecemeal steps rather than drastic moves. The discussions at debrief sessions provide us an ideal platform to materialize this idea. These closed-door discussions allowed the members of research team applied the approaches of clinical diagnosis to help teachers identify the practical problems occurred in their demonstration. The most frequent problems, according to the preliminary analysis, seem to be the mismatch of the level of students' cognitive demands with the specific subject concepts presenting in the demonstrative teaching. This gap needs to be addressed clearly. It is found that teachers may not intend to resist having the collaborative teaching/learning practices a trail at the first place. But the outcome might be counter-productive when they found their students' performance in

collaborative learning was not like that they have seen in the mimic performances conducted by their colleagues in the university's workshops. This could be a very frustrating experience for these teachers. It obviously is a pressing issue for the research team to help teachers be able to connect the concerning theories of instruction with their classroom practices. Apart from this, an in-depth interview with the principal of the participating school which is set to explore the detail of the culture in this educational setting will be conducted at the next step.

Results and Perspectives

As stated, a series of survey, questionnaire and interview with the participating teachers were conducted to find out their attitudes towards this study and to see whether there were any changes of their beliefs in teaching and learning. Preliminary analysis of the data suggests that the new approach did reduce a great deal of worries and doubts of some of the participating teachers. For example, 85% (17 out of 20) of the number of participating teachers appreciated the necessity of making change in their teaching. And 60% of the participating teachers admitted that the year's participating experience have significant impact on them. However we also found that a number of teachers still held negative attitude towards this approach and showed little interest in the idea of establishing a school-based teacher development program. For instance, 40% (8 out of 20) of the number of participating teachers didn't think this action research has impact on them. 55% of the teachers displayed their resisting attitude on adopting new teaching methods. However, it is interesting to find that teachers who were interested in enhancing their teaching and students' learning expressed that they benefited a lot as a result of participating this collaborative research. Their unapologetic attitude may need substantial support from every corner of the school and its community. The principal undoubtedly would be one of the

influential figures who can make crucial decision and show significant support. The trilogy of our aim to construct a school-based teacher professional development model is still on its way. This would never be an easy target to achieve. However through working closely, the research team, the principal and the participating teacher have come up with many solutions. As indicated by the principal of the participating school, that

> "I was told what you [i.e. the participating teachers] care about most are the scores, curriculum pace and pressure from the parents. So you can not adopt alternative constructivist teaching approaches. I would like to ask you why you encourage your own children to learn in accordance with constructivist approaches and hesitate to encourage your students to do so? Don't worry about the scores and the pressure from parents. I will take the responsibilities for you...Moreover, we have learned that the rigid entrance exam systems would be abolished in the near future."

Our final aim is to train teachers who would be able to use the best approaches they could to teach their students. It is like the pursuit of a dream which is portrayed by a science educator:

> "There is much to be done. At best, a very small fraction of learners in our world are engaged in predominantly meaningful learning practices, whether in schools, universities, or workplaces...The extent to which learner- and teacher-held epistemologies influence the quality of learning is still recognized by only a minority of educators, but this situation appears to be improving rapidly..." (Novak, 1998, p.26)

More detailed results, including the influencing factors of the practicability and effectiveness of the project will be presented in the annual meeting.

References

Bridges, D. (1993). School-based teacher education. In D. Bridges & T. Kerry (Eds.), Developing teachers professionally: Reflections for initial and in-service trainers. London: Routledge.

Cheng, S-S., Chang, W-H., Chiang, W-H., & Guo, C-J. (1998). Development of a professional development program for science and mathematics teachers – An action research. Paper presented at the annual meeting of National Association for Research in Science Teaching, San Diego, CA.

Elliott, J. (1991). Action Research for Educational Change. Milton Keynes: Open University Press.

Guo, C-J., Chiang, W-H. & Chang, W-H. (1997) An Action Research Study of the Development of an In-service Teacher Education Program for High School Science and Mathematics Teachers – Teachers' Change and Curriculum Adjustment. (in Chinese with English abstract) Chinese Journal of Science Education, 5(3), 295-320.

Novak, J.D. (1998) The Pursuit of A Dream: Education Can be Improved. In Mintzes, J.J., Wandersee, J.H., & Novak, J.D. (eds) Teaching Science for Understanding – A Human Constructivist View, pp.3-28. Academic Press.

Posner, G.J., Strike, K.A., Hewson, P.W., & Gertzog, W.A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. Science Education, 66(2), 211-228.

Schon, D.A. (1987). Educating the reflective practitioner: Toward a new design for teaching and learning in the professions. San Francisco: Jossey-Bass.

Shymansky, J. A. (1992). Using constructivist ideas to teach science teachers about constructivist ideas, or teachers are students too! Journal of Science Teacher Education, 3(2), 53-57.

Tobin, K. (Ed.). (1993). The practice of constructivism in science education. Washington, D.C.: AAAS Press.

Wang, S-Y. P. (1998) The Role of Science Teachers and Science Teaching in National Development: A Case Study of Taiwan. Unpublished Ph.D. Thesis at the Department of Educational Research, University of Lancaster, U.K.